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TRIBUTARY TO HIGHLAND LAKE
SUSSEX COUNTY
NEW JERSEY

UPPER HIGHLAND LAKE DAM

NJ 00797

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

DEPARTMENT OF THE ARMY

Philadelphia District
Corps of Engineers
Philadelphia, Pennsylvania

AUGUST 1981

REPT. NO: DAEN/NAP-53842/NJ00797-81/07

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REPORT DOCUMENTATION PAGE

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1. REPORT NUMBER: DAEN/NAP-53842/NJ00797-81/08	2. GOVT ACCESSION NO.: AD-A102 667
	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle): Phase I Inspection Report National Dam Safety Program Upper Highland Lake Dam, NJ00797 Sussex County, NJ	5. TYPE OF REPORT & PERIOD COVERED: FINAL
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): Perera, Abraham, P.E.	8. CONTRACT OR GRANT NUMBER(s): DACW61-79-C-0011
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Louis Berger Assoc. 100 Halstead St. East Orange, NJ 07019	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS: NJ Department of Environmental Protection Division of Water Resources P.O. Box CN029 Trenton, NJ 08625	12. REPORT DATE: August, 1981
	13. NUMBER OF PAGES: 50
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office): U.S. Army Engineer District, Philadelphia Custom House, 2d & Chestnut Streets Philadelphia, PA 19106	15. SECURITY CLASS. (of this report): Unclassified
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Bl

National Dam Safety Program. Upper Highland Lake Dam (NJ00797), Hudson River Basin, Tributary to Highland Lake, Sussex County, New Jersey. Phase I Inspection Report.

18. SUPPLEMENTARY NOTES

Copies are obtainable from National Technical Information Service, Springfield, Virginia 22151.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Dams	National Dam Safety Program	Spillways
Embankments	Upper Highland Lake Dam, NJ	Riprap
Visual Inspection	Sussex County, NJ	Sussex County, NJ
Structural Analysis	Hudson River Basin, NJ	Erosion
Erosion	Highland Lake, NJ	

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report cites results of a technical investigation as to the dam's adequacy. The inspection and evaluation of the dam is as prescribed by the National Dam Inspection Act, Public Law 92-367. The technical investigation includes visual inspection, review of available design and construction records, and preliminary structural and hydraulic and hydrologic calculations, as applicable. An assessment of the dam's general condition is included in the report.

DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
CUSTOM HOUSE—2 D & CHESTNUT STREETS
PHILADELPHIA, PENNSYLVANIA 19106

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22 JUL 1981

Honorable Brendan T. Byrne
Governor of New Jersey
Trenton, New Jersey 08621

Dear Governor Byrne:

Inclosed is the Phase I Inspection Report for Upper Highland Lake Dam, Sussex County, New Jersey which has been prepared under authorization of the Dam Inspection Act, Public Law 92-367. A brief assessment of the dam's condition is given in the front of the report.

Based on visual inspection, available records, calculations and past operational performance, Upper Highland Lake Dam, a high hazard potential structure, is judged to be in good overall condition. The dam's spillway is considered inadequate, as 59 percent of the Spillway Design Flood (SDF) would cause the dam to be overtopped. The SDF, in this instance, is one half of the Probable Maximum Flood (PMF). Additional hydraulic and hydrologic studies are believed unnecessary since removal of one of three flashboards at the spillway will increase its capacity sufficiently to accommodate the design flood. To ensure adequacy of the structure, the following actions, as a minimum, are recommended:

a. It is recommended that monitoring of the leak begin immediately along with investigations to determine its cause and the remedial action that might be required. In addition, it is recommended that one of the flashboards be permanently removed or that a method be developed which will absolutely guarantee the removal of at least one flashboard for any discharge condition that may be encountered at the spillway.

b. Within twelve months from the date of approval of this report the following remedial actions should be initiated:

(1) Filling and seeding the eroded areas on the crest and downstream slope of the dam. The upstream face should be protected against wave action by the emplacement of riprap along the crest at the water line.

(2) Tree and brush growing on the downstream side of the embankment should be removed.

(3) If the source of the seep at the toe of the dam cannot be determined, the area should be brought up to the prevailing elevation of the toe utilizing a graded filter material designed to retard flow and prevent the movement of fine material.

(4) All spalled and deteriorated concrete at the spillway should be repaired and the siltation on the upstream side of the weir should be removed.

c. It is recommended that the association's existing work program be expanded to include periodic maintenance of the dam and the development of operational procedures.

d. The owners should develop an emergency action plan and downstream warning system to minimize the potential for flood damage downstream.

A copy of the report is being furnished to Mr. Dirk C. Hofman, New Jersey Department of Environmental Protection, the designated State Office contact for this program. Within five days of the date of this letter, a copy will also be sent to Congressman Courter of the Thirteenth District. Under the provision of the Freedom of Information Act, the inspection report will be subject to release by this office, upon request, five days after the date of this letter.

Additional copies of this report may be obtained from the National Technical Information Services (NTIS), Springfield, Virginia 22161 at a reasonable cost. Please allow four to six weeks from the date of this letter for NTIS to have copies of the report available.

An important aspect of the Dam Inspection Program will be the implementation of the recommendations made as a result of the inspection. We accordingly request that we be advised of proposed actions taken by the State to implement our recommendations.

Sincerely,

Roger L. Baldwin

ROGER L. BALDWIN
Lieutenant Colonel, Corps of Engineers
Commander and District Engineer

1 Incl
As stated

Copies furnished:
Mr. Dirk C. Hofman, P.E., Deputy Director
Division of Water Resources
N.J. Dept. of Environmental Protection
P.O. Box CN029
Trenton, NJ 08625

Mr. John O'Dowd, Acting Chief
Bureau of Flood Plain Regulation
Division of Water Resources
N.J. Dept. of Environmental Protection
P.O. Box CN029
Trenton, NJ 08625

UPPER HIGHLAND LAKE DAM (NJ00797)

CORPS OF ENGINEERS ASSESSMENT OF GENERAL CONDITIONS

This dam was inspected on 24 March 1981 by Louis Berger and Associates, Inc., under contract to the State of New Jersey. The State, under agreement with the U.S. Army Engineer District, Philadelphia, had this inspection performed in accordance with the National Dam Inspection Act, Public Law 92-367.

Upper Highland Lake Dam, a high hazard potential structure, is judged to be in good overall condition. The dam's spillway is considered inadequate, as 59 percent of the Spillway Design Flood (SDF) would cause the dam to be overtopped. The SDF, in this instance, is one half of the Probable Maximum Flood (PMF). Additional hydraulic and hydrologic studies are believed unnecessary since removal of one of three flashboards at the spillway will increase its capacity sufficiently to accommodate the design flood. To ensure adequacy of the structure, the following actions, as a minimum, are recommended:

a. It is recommended that monitoring of the leak begin immediately along with investigations to determine its cause and the remedial action that might be required. In addition, it is recommended that one of the flashboards be permanently removed or that a method be developed which will absolutely guarantee the removal of at least one flashboard for any discharge condition that may be encountered at the spillway.

b. Within twelve months from the date of approval of this report the following remedial actions should be initiated:

(1) Filling and seeding the eroded areas on the crest and downstream slope of the dam. The upstream face should be protected against wave action by the emplacement of riprap along the crest at the water line.

(2) Tree and brush growing on the downstream side of the embankment should be removed.

(3) If the source of the seep at the toe of the dam cannot be determined, the area should be brought up to the prevailing elevation of the toe utilizing a graded filter material designed to retard flow and prevent the movement of fine material.

(4) All spalled and deteriorated concrete at the spillway should be repaired and the siltation on the upstream side of the weir should be removed.

c. It is recommended that the association's existing work program be expanded to include periodic maintenance of the dam and the development of operational procedures.

d. The owners should develop an emergency action plan and downstream warning system to minimize the potential for flood damage downstream.

APPROVED: Roger L. Baldwin
ROGER L. BALDWIN
Lieutenant Colonel, Corps of Engineers
Commander and District Engineer

DATE: 21 July 81

PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM

Name of Dam Upper Highland Lake Dam Fed ID# NJ 00797

State Located	New Jersey
County Located	Sussex
Coordinates	Lat. 41[illegible].7 - Long. 7428.[illegible]
Stream	Unnamed Tributary to Highland Lake
Date of Inspection	March 24, 1981

ASSESSMENT OF GENERAL CONDITIONS

Upper Highland Lake Dam is considered to be in a generally good overall condition although its spillway capacity can accommodate only 58% of the 1/2 PMF design storm. It is recommended that the dam be evaluated within the framework of the high hazard classification due to the high potential for severe property damage and loss of life immediately downstream of the dam. Additional hydraulic and hydrologic studies are believed unnecessary since removal of one of three flashboards at the spillway will increase its capacity sufficiently to accommodate the design flood. Investigations to determine the source of a seep at the downstream toe, and its repair, should begin immediately as should an evaluation of methods to provide for drawdown of the lake. It is recommended that one of the flashboards be removed immediately or that a method be provided that would guarantee removal of a flashboard during periods of high discharge at the spillway. Remedial measures to be undertaken in the near future include the repair of the concrete at the spillway, removal of brush and trees from the embankment, emplacement of riprap on the upstream slope of the dam, repair of the eroded areas on the embankment, and removal of the sedimentation on the upstream side of the spillway weir. It is further recommended that the owner develop an emergency action plan and warning system to reduce the downstream hazard potential.

A Perera

Abraham Perera P.E.
Project Manager

OVERVIEW OF UPPER HIGHLAND LAKE DAM

MARCH, 1981

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PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines can be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of Phase I investigations is to identify expeditiously those dams that may pose hazards to human life or property. The assessment of the general condition of the dam is based on available data and visual inspections. Detailed investigation and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In the review of this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions will be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established guidelines, the spillway test flood is based on the estimated "probable maximum flood" for the region (greatest reasonable possible storm runoff) or fractions thereof. The test flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition, and the downstream damage potential.

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
NAME OF DAM: UPPER HIGHLAND LAKE DAM
FED. I.D.# NJ 00797

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority

This report is authorized by the Dam Inspection Act, Public Law 92-367, and has been prepared in accordance with Contract FPM-36 between Louis Berger & Associates, Inc. and the State of New Jersey and its Department of Environmental Protection, Division of Water Resources. The State, in turn, is under agreement with the U.S. Army Corps of Engineers, Philadelphia to have this inspection performed.

b. Purpose of Inspection

The purpose of this inspection is to evaluate the structural and hydraulic condition of the Upper Highland Lake Dam and appurtenant structures and to determine if the dam constitutes a hazard to human life or property.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances

Upper Highland Lake Dam is a 311-foot-long earth structure with a concrete spillway located at the left abutment. The embankment has a maximum height of 17.6 feet, a crest width of 15 feet, and a downstream slope of 2H:1V. A 15-foot-wide, 48-foot-long concrete and wooden docking and deck structure extends 21 feet into the lake about 100 feet from the right abutment. The 16.75-foot-wide concrete weir has 2 wooden and 1 steel 8-inch-high flashboards and a steel-truss-supported concrete foot bridge extending between the spillway sidewalls. The clear opening at the spillway is presently 19 inches by 16.75 feet. Discharge over the weir drops 6 feet 10 inches to a 20-foot-long concrete apron before entering a small rock-lined stream channel and flowing about 100 feet to a 3-foot by 2-foot oval pipe culvert extending under the community tennis courts.

b. Location

The dam is situated in a small depression on the slopes bordering the west side of Highland Lake; it is located near Highland Lake Road about 500 feet north of its junction with Algonquian Road in Vernon Township, Sussex County, New Jersey. The reservoir is about 175 feet below the crest of Wawayanda Mountain in the north central portion of the community of Highland Lakes and may be reached via Route 515 and Highland Lake Road.

c. Size Classification

The dam has a maximum height of 17.6 feet and a maximum storage capacity of 106 acre-feet. Accordingly, this dam is in the <u>small</u> size category as defined by the criteria in the <u>Recommended Guidelines for Safety Inspection of Dams</u> (storage less than 1,000 acre-feet and height less than 40 feet).

d. Hazard Classification

The dam is located in the middle of extensive residential development in the community of Highland Lakes. The downstream channel decreases in size as it descends the mountain slope and meanders between homes and the residential street system. Community tennis courts are located at the toe of the dam and two homes are situated immediately across the road from the downstream end of the courts. A failure could cause extensive damage to these and other homes and could result in a significant loss of life particularly if the tennis courts were occupied at the time of the failure. Accordingly, it is recommended that this dam be classified as <u>high</u> hazard.

e. Owner

This dam is owned by the Highland Lakes Country Club and Community Association Inc., Highland Lakes, New Jersey.

f. Purpose of Dam

The dam was constructed for the purpose of creating a recreational lake.

g. Design and Construction History

Although there are no engineering or construction records available, other dams created by the same developer in the Highland Lakes community were designed by Newel C. Harrison, Butler, N.J. and constructed by Dollar & VanBlackon, General Contractors of Vernon, N.J. It is possible that the same firms erected this structure.

h. Normal Operating Procedures

There are no formal operating procedures that are applicable to this dam. However, a full-time maintenance staff is employed by the Lake Association for the purpose of groundskeeping and repair.

1.3 PERTINENT DATA

a. Drainage Area

Upper Highland Lake Dam has a drainage area of 0.12 square miles, which consists primarily of woodland and suburban residential development.

b. Total spillway capacity at maximum pool elevation (top of dam) - 162 cfs

c. Elevations (feet above MSL)

Top of dam - 1,272
Spillway crest - 1,269.8
Streambed at centerline of dam - 1,254.4

d. Reservoir

Length of maximum pool (top of dam) - 820 feet

Length of recreational pool (spillway crest) - 800 feet

e. Storage (acre-feet)

Top of dam	- 106.0
Recreation pool	- 84.2

f. Reservoir Surface (acres)

Top of dam	- 10.6
Recreational pool	- 9.2

g. Dam

Type - Earth with concrete spillway at left abutment.

Length - 311 feet

Height - 17.6 feet

Top Width - 15 feet

Side Slopes - 2H:1V downstream; unknown upstream.

Zoning - Unknown

Impervious Core - Unknown

Cutoff - Unknown

Grout Curtain - Unknown

h. Diversion and Regulating Tunnel - None

i. Spillway

Type - Concrete weir with wood and metal flash-boards. Trapezoidal channel at right abutment.

Weir Length - 16.75 feet

Gates - None

U/S Channel - Eight-foot-long sand and gravel approach channel.

D/S Channel - Concrete spillway apron about 20 feet long.

j. Regulating Outlets

None - no draw down facilities.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

A search of various agencies and discussions with the owner's representatives failed to produce any design details, reports, or drawings. All dimensions depicted herein were measured in the field.

2.2 CONSTRUCTION

Although it is believed this dam was constructed by the same contractor that built the other dams in this region, no construction details were available to the inspection team. The contractor could not be located nor were as-built plans available. There are no records of the construction plans having been filed with the NJDEP or of any inspections made by State engineers.

The dam is located in a region underlain by the Pre-Cambrian age Byram gneiss, a dense, hard, and characteristically banded metamorphic granitoid. The reservoir occupies a small, rock-bound depression caused by glacial scouring. The thin overburden in this area consists primarily of silt and organic material.

2.3 OPERATION

No data pertaining to the operation at this dam was obtained (see Section 4).

2.4 EVALUATION

a. Availability

Although the hydraulic and hydrologic conditions could be determined from field measurements and observations, several design criteria could not be evaluated due to a lack of engineering data, including the depth to bedrock, condition of foundation, existence and configuration of a cutoff or corewall, and the relative permeability of the embankment.

b. Adequacy

Although no information pertaining to the dam's internal makeup was obtained, field observations complimented by hydraulic and hydrologic calculations performed by the inspection team, provided sufficient data on which to base an assessment of the dam's overall safety within the purview of PL 92-367.

c. Validity

No design data are available for assessment.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General

Visual inspection of Upper Highland Lake Dam (a.k.a. Lake One Dam) was performed on March 24, 1981 at which time the lake level was about 5 inches below the top of the flashboards since the flashboards were wedged open slightly to keep the lake at a lower elevation during the winter. The dam appears to be in generally good condition although some light erosion was noted on the downstream embankment and a substantial seep was observed at the toe of the dam about 100 feet to the right of the spillway.

b. Dam

The dam's embankment is in fairly good condition, although it is slightly uneven horizontally. The back portion of the crest is generally 4 to 6 inches higher than the front as a result of pedestrian traffic. Minor erosion was noted along the upstream edge of the crest, presumably due to wave action, and at two locations on the downstream slope, which appear to be paths. Erosion was also noted adjacent to the spillway wingwall and the concrete portion of the dock and deck structure. While the downstream slope of the embankment has a substantial grass cover, it also supports numerous pine trees, some as large as 18 inches in diameter. A substantial seep was observed slightly beyond the toe of the dam and about 100 feet to the right of the spillway. The seepage area contains a 1-foot-deep standing pool of water that is about 6 feet by 15 feet in areal extent and appears to be about 3 feet lower in elevation than the prevailing dam toe elevation. A wet, leaf-covered channel extends from the seep and intersects the spillway outlet channel near the oval pipe culvert. The water in the seepage pool contains a thick orange precipitate, suggesting the possibility of iron piping in this area, although none was observed or reported at this location.

c. Appurtenant Structures

The spillway and sidewalls are in fair overall condition although some concrete deterioration, consonant with the age of the structure, was observed. Spalling and cracking of the spillway apron was observed, and a horizontal crack extended the width of the spillway about 18 inches below the top of the weir. Spalling was also somewhat more severe at the junction of the spillway slab and apron.

d. Reservoir Area

The terrain surrounding the lake is gently sloping with extensive suburban development to the east and west and less densely developed woodlands to the north. A sandy beach is located at the right abutment and several docks dot the shoreline of the lake. Although not discernible along the face of the dam, there is a sediment build-up at the spillway that extends to within 3 feet of the top of the wingwall. This level is about 7 inches higher than the concrete weir crest and seems to indicate that the lake is always lowered by placing edges between the two owest flashboards, causing the siltation level to remain at that elevation.

e. Downstream Channel

The downstream channel is small and narrow, extending diagonally from the spillway to the edge of the tennis courts, where it enters a 2-foot by 3-foot CMP culvert that extends under the courts and a road another 150 feet downstream. The terrain surrounding the channel is relatively flat and lightly wooded. The tennis courts located to the right of the channel are 6.1 feet higher in elevation than the culvert invert. The culvert invert is also 4.3 feet lower than the toe of the dam. During extremely high discharges, the area between the tennis courts and the left abutment area must flood due to the relatively small discharge capacity of the culvert. A 6-foot, 8-inch-high timber retaining wall is located at the downstream end of the tennis courts. A local road extends along the bottom of the retaining wall and two homes are located on the opposite side of the road. The channel on the downstream side of the road is deeper and wider with steep side slopes. Several homes are situated near the top of the channel 500 to 700 feet downstream.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

There are no formal operating procedures presently in existence although the Lake Association employs a permanent maintenance crew in addition to seasonal part-time help. This staff is resonsible for groundskeeping, preventive maintenance, lake operations, and repairs to the community property, but present operations are restricted by funding limitations.

4.2 MAINTENANCE OF DAM

While the primary responsibility of the maintenance staff centers around groundskeeping, their duties also extend to repair work within their capability. It appears that the dam is presently maintained in an adequate manner, although attention could be concentrated in the area of the growth and light erosion on the embankment backslope.

4.3 MAINTENANCE OF OPERATING FACILITIES

The only regulatory components at the dam are the spillway flashboards. While no formal maintenance procedures exist for this facility, it is apparently repaired on an as-needed basis and does not appear to exhibit any obvious signs of neglect.

4.4 DESCRIPTION OF WARNING SYSTEM IN EFFECT

No formal warning system is presently in effect. Although residents living near the dam might observe hazardous conditions during heavy storms and notify local authorities, it was observed that the downstream homes are situated in very vulnerable locations with respect to flood flows. It is believed that only an automated warning system could provide sufficient advance notice downstream in the event of a dam failure.

4.5 EVALUATION OF OPERATIONAL ADEQUACY

The present operational procedures and community safeguards are deemed to be inadequate in view of the location and position of the dam and the potential to downstream damage. A general community warning system and emergency action plan should be developed along with a more intensive program of inspection and maintenance.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data

In accordance with the criteria presented in the Recommended Guidelines for Safety Inspection of Dams, it has been determined that the Upper Highland Lake Dam is small in size and falls within the high hazard category. Accordingly, the spillway design flood (SDF) was determined by the inspection team to be one-half the probable maximum flood (PMF). The inflow hydrograph was calculated using precipitation data from Technical Paper 40 and Technical Memo NWS Hydro-35. In accordance with Corps of Engineers directives, the inflow hydrograph and flood routing were performed utilizing the HEC-1 computer program. Peak inflow to the reservoir for the 1/2 PMF was 578 cfs. When routed through the reservoir, this flow was reduced to 279 cfs. The spillway capacity before overtopping occurs is 162 cfs and therefore can only accommodate 58% of the design flood. In its present configuration, the spillway capacity is inadequate although not seriously inadequate since the short duration and low velocity of overtopping during the design storm would probably not result in a dam failure. (See paragraph 5.1 d, Overtopping Potential).

b. Experience Data

There were no operational records or experience information available to the inspection team concerning this dam.

c. Visual Observations

There are no indications that the dam has ever been overtopped, although hydraulic calculations indicate overtopping is possible with the 1/2 PMF design storm. The inspection team noted that the spillway flashboards limit the discharge capacity considerably and the steel bridge truss could serve to entrap debris during severe storms, further reducing the ability of the spillway to accommodate heavy storm runoff.

d. Overtopping Potential

Based on the hydraulic evaluation, it appears that the dam would be overtopped by 2.0 inches for approximately 30 minutes during the 1/2 PMF design storm. The maximum velocity of the discharge over the dam would be about 2.25 feet per second which, due to the short duration of the overtopping, would probably not cause significant damage to the dam or result in a dam failure. However it is recommended that the overtopping potential be completely eliminated by the removal of one of the three 8-inch flashboards. This would increase the spillway capacity to 260 cfs and reduce the routed outflow to 220 cfs enabling the spillway to transmit the design storm without overtopping the dam.

e. Drawdown

No draw down facilities were observed at this dam. This is considered a serious deficiency and if, in fact, no blowoff exists, studies should be implemented to determine a feasible method of draining the lake during emergency conditions.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations

No deficiencies of a structural nature were noted during the inspection of this dam. The crest is relatively uniform in a horizontal plane, and although the width of the dam crest varies slightly, the maximum height-to-width ratio is relatively modest (1.1:1). No indications of mass movement of material, such as settlement, sloughing, or cracking, were noted. However, the leak observed 100 feet to the right of the spillway has the potential to develop into a more serious problem if left uncorrected.

b. Design and Construction Data

As indicated in Section 2, no information is available regarding the design or construction history of the dam. However, the field observations are considered adequate to render an evaluation of this dam's structural integrity.

c. Operating Records

While no formal operating records are maintained by the lake association, the dam appears to have performed satisfactorily since its construction.

d. Post Construction Changes

There are no records of any structural modifications performed at this dam nor do field observations suggest there have been structural changes since the original construction.

e. Seismic Stability

Upper Highland Lake Dam is located in Seismic Zone 1, where seismic activity is slight and additional structural loading imparted thereby is generally insignificant. Experience indicates that earthen dams in Zone 1 that are stable under static loading conditions will maintain their structural integrity

when subjected to the negligible dynamic loads imposed by the weak seismicity characteristic of this area. As indicated in the preceding paragraphs, this dam is considered statically stable within its present configuration, and it is assumed that it will remain stable during seismic loading.

SECTION 7 - ASSESSMENTS/RECOMMENDATIONS/ REMEDIAL ACTIONS

7.1 DAM ASSESSMENT

a. Safety

Subject to the inherent limitations of the Phase I visual inspection, Upper Highland Lake Dam is judged to be in a generally good condition. However, the spillway is capable of accommodating only 58% of the 1/2 PMF design storm with the flashboards in place. The spillway capacity can be increased to 260 cfs by providing for removal of the top flashboard during periods of high inflow. It is recommended that this dam be placed in the high hazard category due to the high potential for loss of life and severe property damage immediately downstream of the dam.

b. Adequacy of Information

With the exception of visual observations, no information was available for use in evaluating the condition of this dam. Although no data, relative to the composition or construction of the embankment was located, field observations revealed nothing of concern with respect to the condition of the dam. The geometry of the structure is quite uniform and it has a generally well-tended appearance. Accordingly, the information gathered in the field is considered adequate to render an evaluation of the dam's condition within the purview of PL 92-367.

c. Urgency

While implementation of the recommendations pertaining to routine maintenance may be undertaken in the near future, it is felt that monitoring of the leak should begin immediately.

d. Necessity for Further Study

Since removal of one of the three 8-inch flashboards will increase the spillway capacity sufficiently to accommodate the 1/2 PMF design storm, no additional H&H studies are recommended at this

time. However, the source of the leak at the toe of the dam should be investigated to determine if this is, in fact, the location of a low-level blowoff pipe drain. If no drain can be located at the dam, it is recommended that studies be implemented to determine the most feasible manner of providing adequate draw down facilities at the dam.

7.2 RECOMMENDATIONS/REMEDIAL MEASURES

a. Recommendations

It is recommended that monitoring of the leak begin immediately along with investigations to determine its cause and the remedial action that might be required. In addition, it is recommended that one of the flashboards be permanently removed or that a method be developed which will absolutely guarantee the removal of at least one flashboard for any discharge condition that may be encountered at the spillway. Remedial actions to be performed in the near future include:

(1) Filling and seeding the eroded areas on the crest and downstream slope of the dam. The upstream face should be protected against wave action by the emplacement of riprap along the crest at the water line.

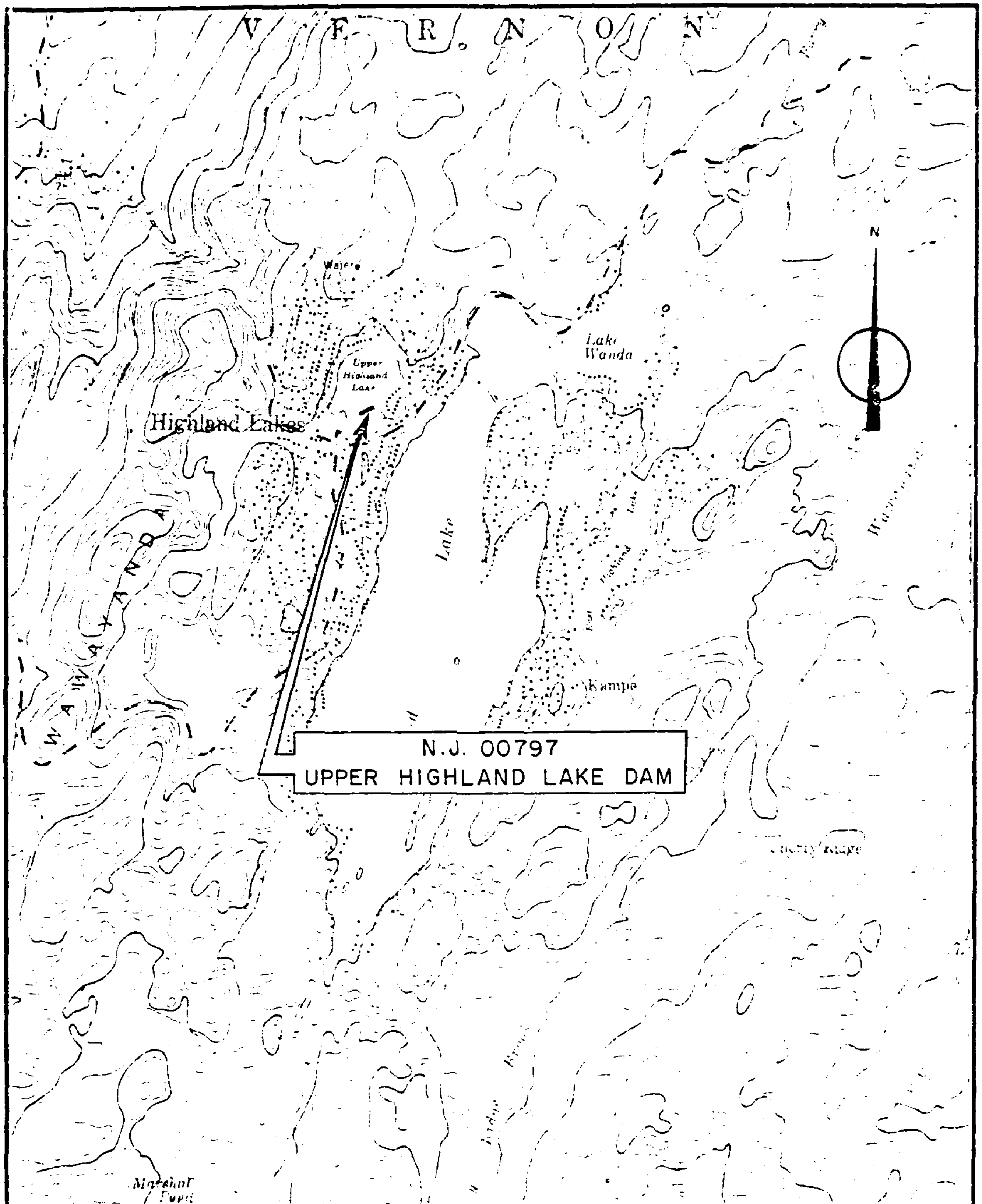
(2) Tree and brush growing on the downstream side of the embankment should be removed.

(3) If the source of the seep at the toe of the dam cannot be determined, the area should be brought up to the prevailing elevation of the toe utilizing a graded filter material designed to retard flow and prevent the movement of fine material.

(4) All spalled and deteriorated concrete at the spillway should be repaired and the siltation on the upstream side of the weir should be removed.

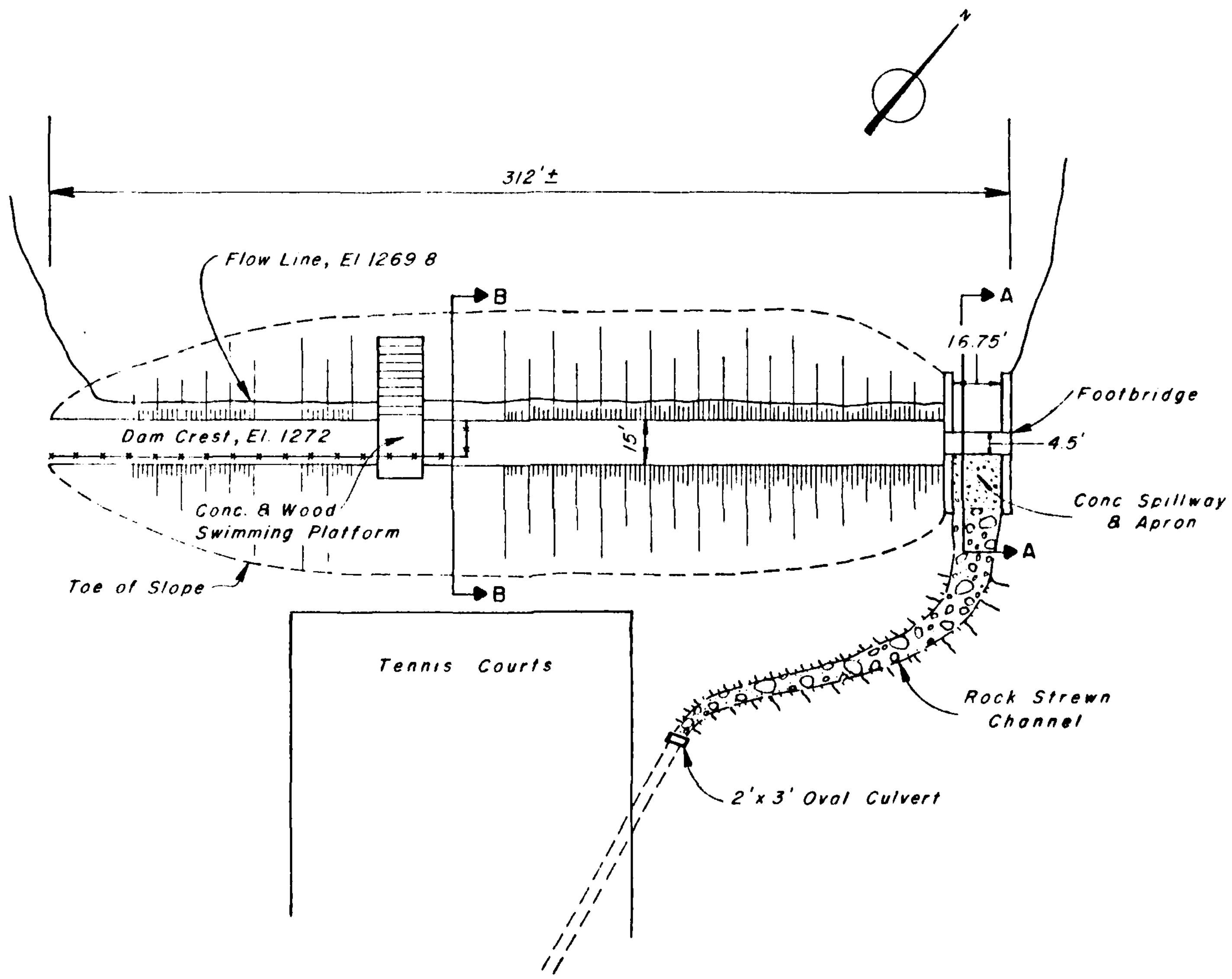
b. O&M Maintenance and Procedures

It is recommended that the association's existing work program be expanded to include periodic maintenance of the dam and the development of operational procedures. The owners should develop an emergency action plan and downstream warning system to minimize the potential for flood damage downstream.



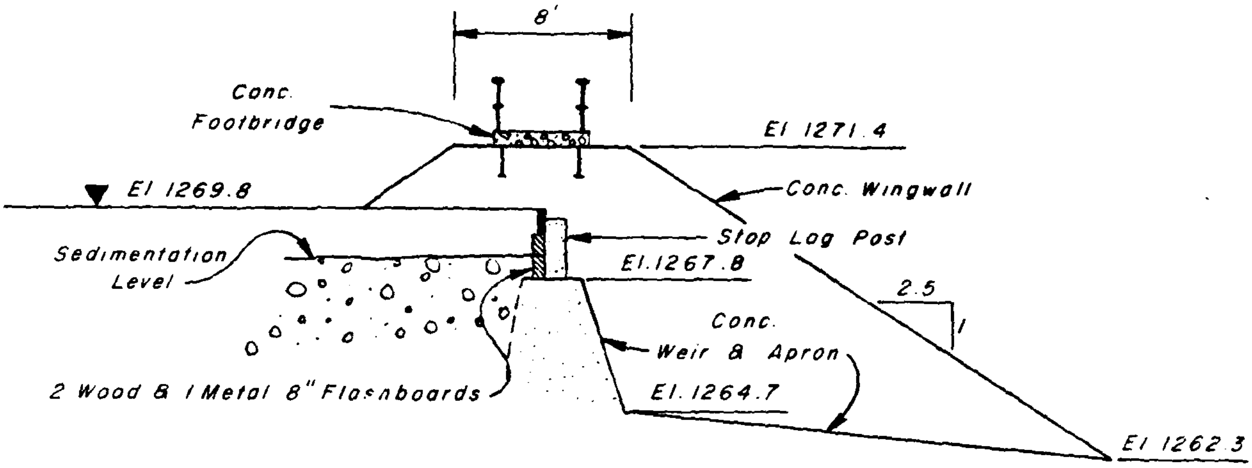
Quad Sheet - Wawayanda, N.J. - N.Y.

FIGURE 1
REGIONAL VICINITY MAP
SCALE 1:24,000

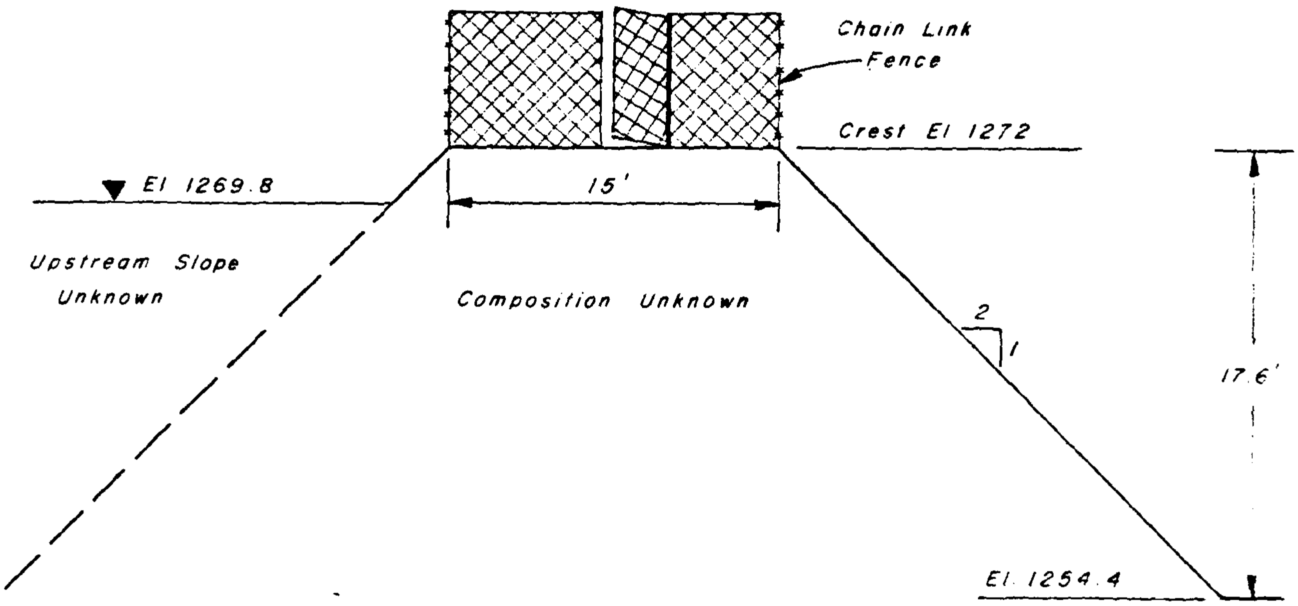


PLAN OF UPPER
HIGHLAND LAKE DAM
NOT TO SCALE

FIGURE 2



SECTION A-A
SPILLWAY ELEVATIONS
NOT TO SCALE



SECTION B-B
EMBANKMENT ELEVATIONS
NOT TO SCALE

UPPER HIGHLAND LAKE DAM

FIGURE 3

Check List
Visual Inspection
Phase 1

Name Dam Upper Highland Lake **County** Sussex **State** New Jersey **Coordinators** NDEP

Date(s) Inspection 3-24-81 **Weather** Sunny **Temperature** 40°

Pool Elevation at Time of Inspection 1269.4 **M.S.L.** **Tailwater at Time of Inspection** 1260.7 **M.S.L.**

Inspection Personnel:

T. Chapter

A. Perera

Representative of owner not present.

A. Perera **Recorder**

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None observed	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None observed	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	Light erosion downstream.	Appear to be paths. Should be filled.
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	Horizontal and vertical alignment slightly irregular.	Vertical alignment irregularity apparently due to wear from foot traffic. Horizontal alignment irregularities due to wave and ice action.
RIPRAP FAILURES	N/A	No riprap observed

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
VEGETATION	Numerous tall pines up to 18" in diameter on the downstream slope.	Should be removed.
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Embankment grades uniformly into adjacent slopes.	No cracking or separations observed.
ANY NOTICEABLE SEEPAGE	Heavy seepage at toe of dam approximately 100 feet from left abutment. Seepage pool approximately 15 x 6 feet and 1 foot deep. Orange precipitate in seepage.	Site of seepage is approximately 3 feet lower than prevalent dam toe elevation. Seepage should be monitored.
STAFF GAGE AND RECORDER	None observed	
DRAINS	None observed	Stone surfacing around edge of tennis court.

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	Downstream face of weir scaling. Light spalling and efflorescence on left downstream wingwall; others satisfactory.	Repair deteriorated concrete.
APPROACH CHANNEL	Lake bottom sandy silt and gravel.	Silted to within 3 feet of top of wingwalls. Should be cleaned.
DISCHARGE CHANNEL	Channel is narrow (3 to 5 feet wide), approximately 2 feet deep, and filled with small boulders; banks are wooded.	Channel ends in 2' x 3' oval CM culvert, which appears to be a severe constriction during heavy storms.
BRIDGE AND PIERS	Steel truss of concrete footbridge may collect debris and constrict discharge. Bridge appears to hamper removal of flashboards.	Spillway should be monitored during heavy storms and kept free of debris. Method of removing flashboards should be devised.

INSTRUMENTATION

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None	
OBSERVATION WELLS	None	
WEIRS	None	
PIEZOMETERS	None	
OTHER	v	

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Slopes gentle, beaches and wooded.	Homes surrounding lake, several docks.
SEDIMENTATION	Siltation observed in approach channel to spillway.	

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Narrow, rocky channel in flat area adjoining tennis courts. Channel enters 2' x 3' oval culvert about 100 feet downstream. Road about 250 feet downstream 6'-7' lower in elevation than tennis courts.	Road and tennis courts would be inundated in event of dam failure.
SLOPES	Very flat downstream area about 300 feet wide. Side slopes gentle.	
APPROXIMATE NO. OF HOMES AND POPULATION	Two homes located directly across street from tennis court. Several homes adjacent to stream channel 500-700 feet downstream.	Tennis courts and homes adjacent to road would be seriously damaged by flood. Homes near downstream channel could also be endangered.

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

ITEM	REMARKS
PLAN OF DAM	None Available
REGIONAL VICINITY MAP	USGS Quandrangle - Wawayunda N.J. - N.Y.
CONSTRUCTION HISTORY	None Available
TYPICAL SECTIONS OF DAM	None Available
HYDROLOGIC/HYDRAULIC DATA	None Available
OUTLETS - PLAN	None Available
- DETAILS	None Available
-CONSTRAINTS	None Available
-DISCHARGE RATINGS	None Available
RAINFALL/RESERVOIR RECORDS	None Available

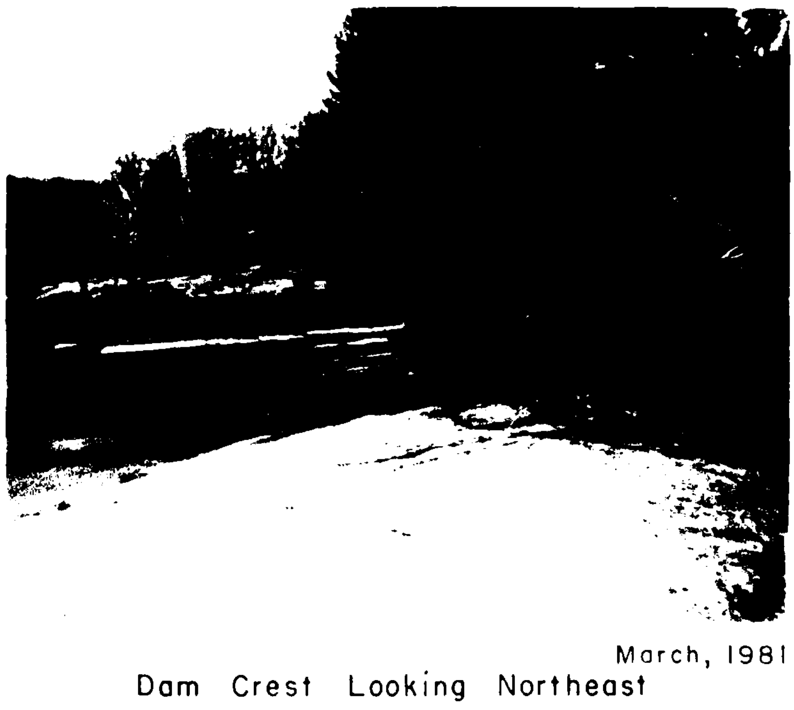
ITEM	REMARKS
SPILLWAY PLAN	None Available
SECTIONS	None Available
DETAILS	None Available
OPERATING EQUIPMENT	None Available
PLANS & DETAILS	None Available

ITEM	REMARKS
DESIGN REPORTS	None Available
GEOLOGY REPORTS	None Available
DESIGN COMPUTATIONS	None Available
HYDROLOGY & HYDRAULICS	None Available
DAM STABILITY	None Available
SEEPAGE STUDIES	None Available
MATERIALS INVESTIGATIONS	None Available
BORING RECORDS	None Available
LABORATORY	None Available
FIELD	None Available
POST-CONSTRUCTION SURVEYS OF DAM	None Available
BORROW SOURCES.	Unknown

x

ITEM	REMARKS
MONITORING SYSTEMS	None
MODIFICATIONS	Information Not Available
HIGH POOL RECORDS	Information Not Available
POST CONSTRUCTION ENGINEERING	Information Not Available
STUDIES AND REPORTS	Information Not Available
PRIOR ACCIDENTS OR FAILURE OF DAM	Information Not Available
DESCRIPTION	Information Not Available
REPORTS	Information Not Available
MAINTENANCE	Information Not Available
OPERATION	Information Not Available
RECORDS	Information Not Available

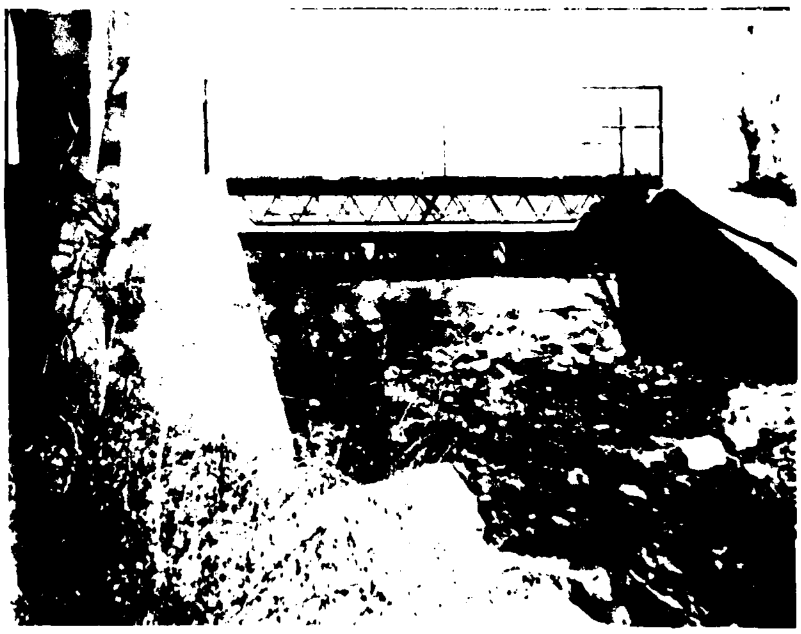
March, 1981
Dam Crest Looking Southwest



March, 1981
Dam Crest Looking Northeast

March, 1981

Upstream View of Spillway



March, 1981

Downstream View of Spillway

March, 1981

Seepage at Downstream Toe

March, 1981

Downstream Channel and Pipe Culvert

CHECK LIST
HYDROLOGIC AND HYDRAULIC DATA
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: 0.12 sq. mi.

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 1269.8 NGVD (84.0 ac.ft.)

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): -

ELEVATION MAXIMUM DESIGN POOL: -

ELEVATION TOP DAM: 1272 NGVD (106.0 acre-feet)

CREST: Spillway

a. Elevation 1267.8 NGVD (Top of concrete weir)
b. Type Concrete Weir
c. Width Approximately 24 inches
d. Length 16.75 feet
e. Location Spillover Left Abutment
f. Number and Type of Gates Three 8-inch-high flashboards

OUTLET WORKS: None observed

a. Type
b. Location
c. Entrance inverts
d. Exit inverts
e. Emergency draindown facilities

HYDROMETEOROLOGICAL GAGES: None

a. Type
b. Location
c. Records

MAXIMUM NON-DAMAGING DISCHARGE: 162 cfs

BY [illegible] DATE [illegible] **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. [illegible] OF [illegible]
CHKD. BY ______ DATE ______ [illegible] PROJECT [illegible]
SUBJECT [illegible] Concentration

[illegible] = [illegible]

Method 1

[illegible] = [illegible]

Δ [illegible] = [illegible]

From [illegible] of Small Dams Fig [illegible]

Assume [illegible] velocity [illegible], T_c = [illegible]

[illegible] Flow

length = 600'

Δ [illegible] = 100' ∴ Slope [illegible]

From Design of Small Dams Fig [illegible]

Assume [illegible] Flow [illegible] ∴ T_c = [illegible]

Total T_c = 5 + 3 [illegible] = .13 [illegible]

Method 2 [illegible]

[illegible] t_c = [illegible] = [illegible] = .0 341

[illegible] t_c [illegible] 3 min [illegible] .05 [illegible]

Total T_c [illegible] .13 hr

Method 3 SCS Method [illegible] Source SCS [illegible]

[illegible] Soil Group [illegible] [illegible]

CN = 66

[illegible] = [illegible] $S = \frac{1000}{CN} - 10$ = [illegible] .515

[illegible] length = 1500'

$L = L_{ag} = \frac{\ell^{0.8}(S+1)^{0.7}}{1900\,Y^{0.5}}$ = [illegible] = [illegible] = .21 hrs

t_c = Lag/.6 = .21/.6 = .35

Av T_c = [illegible] = .2 hr

[illegible] = .2 [illegible] SCS Unit [illegible]

BY [illegible] DATE [illegible]

LOUIS BERGER & ASSOCIATES INC.

SHEET NO [illegible] OF [illegible]

CHKD. BY ______ DATE ______ [illegible]

PROJECT [illegible]

SUBJECT [illegible]

PRECIPITATION DATA

From Hydrometeorological Report #33 for 10 sq. mi. area and 24 hours (in inches)

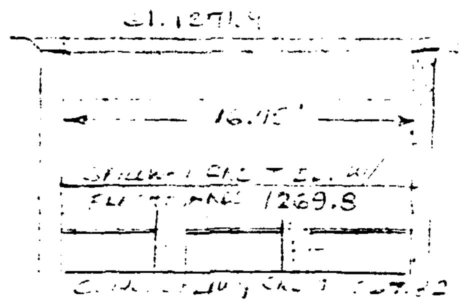
PMP in inches 21.5

For drainage area .13 sq. mi.

Maximum 6 hour percentage = 111 %

Max. Adj. 12 hour percentage = 123 %

Max Adj. 24 hour percentage = 134 %



[illegible] (P) = [illegible]

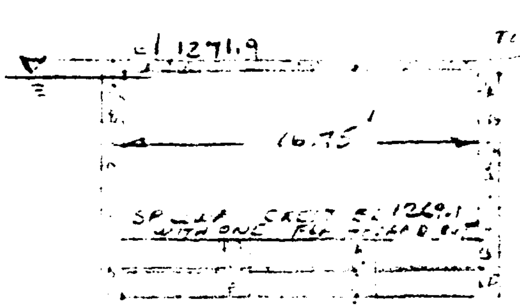
FLOW OVER SPILLWAY [illegible] | FLOW OVER [illegible] | FLOW OVER [illegible] | TOTAL
[illegible] | [illegible] | [illegible] | [illegible]

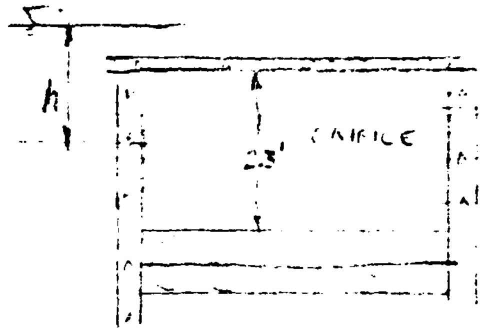
L = 16.15'
[illegible] ELEV. 1269.75
[illegible]

ELEVATION	H	C	Q							TOTAL
[illegible]	[illegible]	—								
[illegible]	[illegible]	—								
[illegible]	.2	3.0	5							5
[illegible]	[illegible]	3.2	70							70
[illegible]	1.6	3.2	105							105
[illegible]	[illegible]	[illegible]	[illegible]							[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	—	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	0.6	[illegible]	32	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	210	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible] ORIFICE

[illegible]





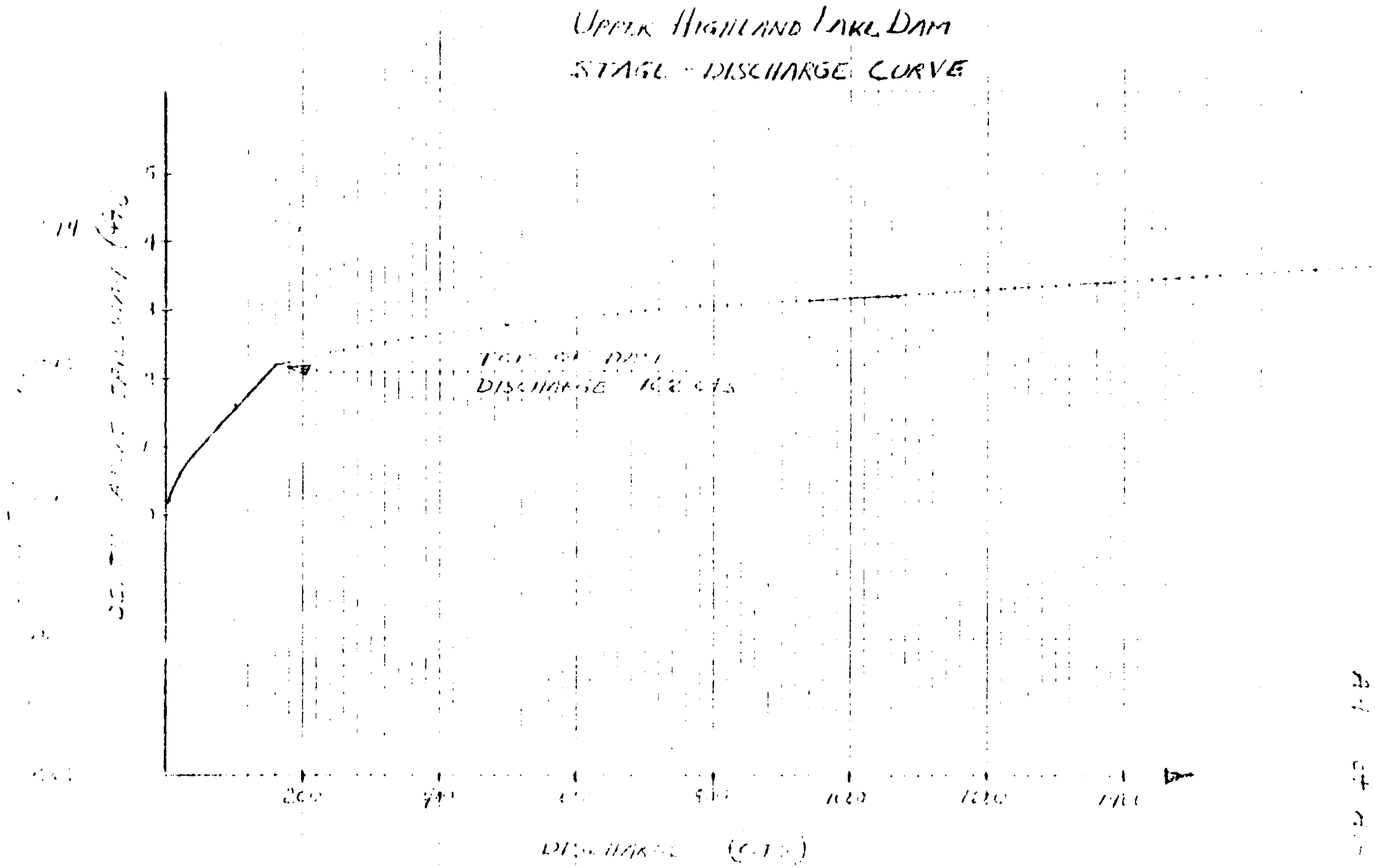
Flow over Spillway boards
when boards removed
Sharp crested weir
Crest Elev. 1269.1 L=16.75
$Q = CLH^{3/2}$ (weir)
$Q = CA\sqrt{2gh}$ (orifice)

Flow over Footbridge
L = 16.75
$Q = CLH^{3/2}$

Flow over Dam
Broad crested weir
L = [illegible]
Dam el 1272
$Q = CLH^{3/2}$

Total Flow

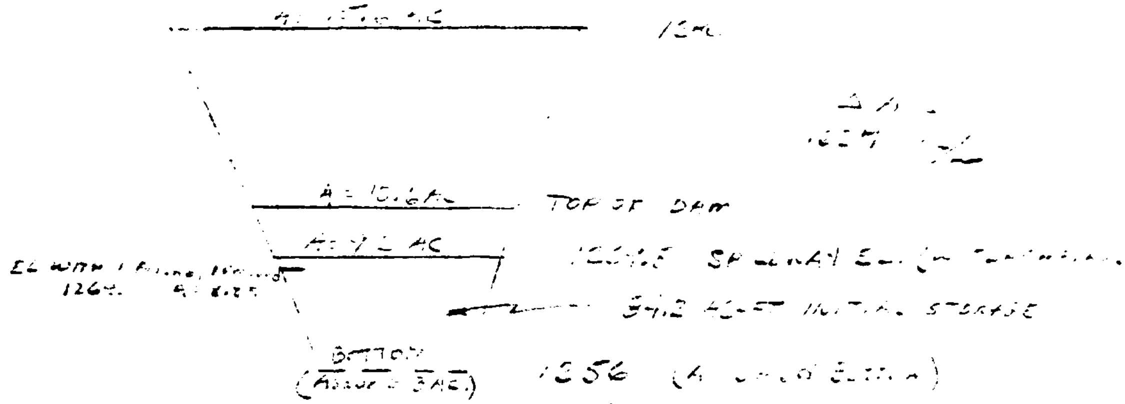
ELEVATION	H or h	C	Q	h	C	Q	H	C	Q	Total Flow
1269.1	0	3.2	0							0
1270.0	.9	3.2	46							46
1271.0	1.9	3.2	140							150
1271.4	2.3	3.2	87							210
	ORIFICE									
1271.9	1.65	.63	250	0		0				250
1272.0	1.75	.63	255	.1	2.8	2	0		0	260
1272.5	2.25	.63	292	.6	2.8	22	.5	2.8	287	601
1273.0	2.75	.63	323	1.1	2.8	[illegible]	1	2.8	[illegible]	[illegible]
1274.0	3.75	.63	377	2.1	2.8	[illegible]	2	2.8	[illegible]	[illegible]


UPPER HIGHLAND LAKE DAM
STAGE - DISCHARGE CURVE
TOP OF DAM
DISCHARGE
0
5
200
DISCHARGE (CFS)

BY [illegible] DATE [illegible] **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. [illegible] OF [illegible]

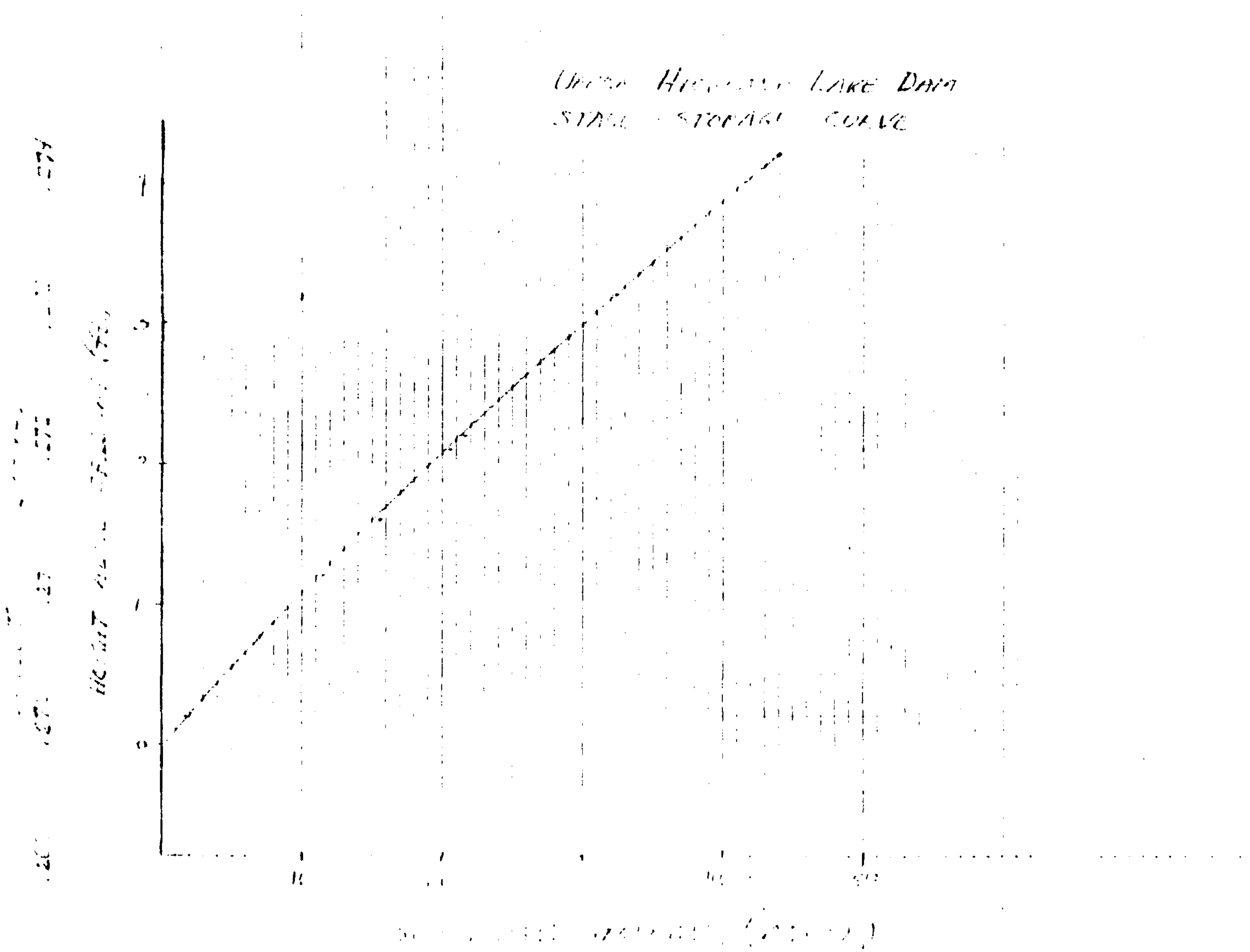
CHKD. BY ______ DATE ______ [illegible] PROJECT [illegible]

SUBJECT [illegible]



ELEVATION (MSL)	FT. ABOVE SPILLWAY CREST (FT.)	AREA OF STORAGE (AC.)	STORAGE VOLUME (AC-FT)	TOTAL VOLUME
1256.0		[illegible]		0
[illegible]	0	9.2		84.2
[illegible]	.2	9.3	1.85	[illegible]
[illegible]	1.2	9.9	11.72	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	2.	10.	20.65	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	116.3
[illegible]	[illegible]	11.9	[illegible]	[illegible]

1269.1 8.89 AC. [illegible]


LAKE DAM
STAGE STORAGE CURVE

BY [illegible] DATE [illegible] **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. [illegible] OF [illegible]

CHKD. BY ______ DATE ______ [illegible] PROJECT [illegible]

SUBJECT [illegible]

```
A1   UPPER HIGHLAND LAKE DAM
A2   J  CERAVOLO
A3   APRIL 30 1981
B    100      0       5       0                 0       0       0
B1     5
J      1      1       1
J1     3
K      0      1                                         1
K1   INFLOW HYDROGRAPH TO RESERVOIR
M      1      2      12                 12
P      0     21 9   111   ~~[illegible]~~  134
                           23
T                                                       5       1
W2           12
X      0      0       1
K      1      2                                         1
K1   ROUTED FLOW THROUGH RESERVOIR
Y                             1
Y1     1                                              84 2     -1
Y41269 8   1270    1271  1271 4  1271 9    1272  1272 5    1273    1274
Y5     0      5      70     108     154     162     496    1076    2690
$6     0   84 2    85 1    90 7    99 7   104 9   106 0   116 8   120 0
$E  1258 1269 8    1270    1271  1271 4  1271 9    1272    1273    1274
$$1269 8
$D  1272
K     99
```

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
100	0	5	0	0	0	0	0	0	0
			JOPER	NWT	LROPT	TRACE			
			5	0	0	0			

INFLOW HYDROGRAPH TO RESERVOIR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	2	0 12	0 00	0 12	0 00	0 000	0	0	0

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0 00	0 00	1 00	0 00	0 00	1 00	0 50	0 10	0 00	0 00

UNIT HYDROGRAPH DATA

(TIME INCREMENT TOO LARGE--(NHQ IS GT LAG/2)) *LEAVE INCREMENT AS IT IS PER GEORGE SAULS*

SUB-AREA RUNOFF COMPUTATION

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0 00	21 9	111 00	126 00	134 00	0 00	0 00	0 00

TRSPC COMPUTED BY THE PROGRAM IS 0 800

TC= 0 00 LAG= 0 12

RECESSION DATA

STRTQ= 0 00 QRCSN= 0 00 RTIOR= 1 00

UNIT HYDROGRAPH [illegible] END OF PERIOD ORDINATES, TC= 0 00 HOURS, LAG= 0 12 VOL= 1 00

215 224 112 55 21 8 3 1

PEAK 6-HOUR 24-HOUR 72-HOUR TOTAL VOLUME

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	[illegible]	0	0	0	0	0	0	0
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	0	0	0
[illegible]	[illegible]	[illegible]	13	13	13	13	13	13	13
13	13	13	13	13	13	13	13	13	13
13	13	13	13	13	13	13	13	13	13
13	13	13	13	13	13	13	13	13	13
13	13	13	13	13	13	13	13	13	13
13	13	13	13	13	13	13	13	13	13
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	71	71	71
[illegible]	[illegible]	[illegible]	[illegible]	86	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	574	[illegible]	269	167
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	121

LOUIS BERGER & ASSOCIATES INC.

BY ______ DATE ______ SHEET NO ____ OF ____

CHKD. BY ______ DATE ______ PROJECT ______

SUBJECT ______

END-OF-PERIOD FLOW

MO DA	HR MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO DA	HR MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1 01	0 06	1	0.01	0.00	0.01	0	0.00	0.00	121	0.19	0.18	0.01	95
1 01	0 12	2	0.01	0.00	0.01	0	0.00	0.00	122	0.19	0.16	0.01	108
1 01	0 18	3	0.01	0.00	0.01	0	0.00	0.00	123	0.19	0.16	0.01	127
1 01	0 24	4	0.01	0.00	0.01	0	0.00	0.00	124	0.19	0.18	0.01	139
1 01	0 30	5	0.01	0.00	0.01	0	0.00	0.00	125	0.19	0.16	0.01	141
1 01	0 36	6	0.01	0.00	0.01	0	0.00	0.00	126	0.19	0.18	0.01	142
1 01	0 42	7	0.01	0.00	0.01	0	0.00	0.00	127	0.19	0.18	0.01	145
1 01	0 48	8	0.01	0.00	0.01	0	0.00	0.00	128	0.19	0.18	0.01	143
1 01	0 54	9	0.01	0.00	0.01	0	0.00	0.00	129	0.19	0.18	0.01	143
1 01	1 00	10	0.01	0.00	0.01	0	0.00	0.00	130	0.19	0.18	0.01	143
1 01	1 06	11	0.01	0.00	0.01	0	0.00	0.00	131	0.23	0.22	0.01	151
1 01	1 12	12	0.01	0.00	0.01	0	0.00	0.00	132	0.23	0.22	0.01	164
1 01	1 18	13	0.01	0.00	0.01	0	0.00	0.00	133	0.23	0.22	0.01	169
1 01	1 24	14	0.01	0.00	0.01	0	0.00	0.00	134	0.23	0.22	0.01	172
1 01	1 30	15	0.01	0.00	0.01	0	0.00	0.00	135	0.23	0.22	0.01	172
1 01	1 36	16	0.01	0.00	0.01	0	0.00	0.00	136	0.23	0.22	0.01	173
1 01	1 42	17	0.01	0.00	0.01	0	0.00	0.00	137	0.23	0.22	0.01	173
1 01	1 48	18	0.01	0.00	0.01	0	0.00	0.00	138	0.23	0.22	0.01	173
1 01	1 54	19	0.01	0.00	0.01	0	0.00	0.00	139	0.23	0.22	0.01	173
1 01	2 00	20	0.01	0.00	0.01	0	0.00	0.00	140	0.23	0.22	0.01	173
1 01	2 06	21	0.01	0.00	0.01	0	0.00	0.00	141	0.25	0.28	0.01	186
1 01	2 12	22	0.01	0.00	0.01	0	0.00	0.00	142	0.29	0.26	0.01	205
1 01	2 18	23	0.01	0.00	0.01	0	0.00	0.00	143	0.29	0.28	0.01	213
1 01	2 24	24	0.01	0.00	0.01	0	0.00	0.00	144	0.29	0.28	0.01	216
1 01	2 30	25	0.01	0.00	0.01	0	0.00	0.00	145	0.29	0.28	0.01	217
1 01	2 36	26	0.01	0.00	0.01	0	0.00	0.00	146	0.29	0.28	0.01	218
1 01	2 42	[illegible]	0.01	0.00	0.01	[illegible]	0.00	0.00	147	0.29	0.28	0.01	218
1 01	2 48	28	0.01	0.00	0.01	0	0.00	0.00	148	0.29	0.28	0.01	218
1 01	2 54	29	0.01	0.00	0.01	0	0.00	0.00	149	0.29	0.28	0.01	218
1 01	3 00	30	0.01	0.00	0.01	0	0.00	0.00	150	0.29	0.28	0.01	218
1 01	3 06	31	0.01	0.00	0.01	0	0.00	0.00	151	0.30	0.29	0.01	219
1 01	3 12	32	0.01	0.00	0.01	0	0.00	0.00	152	0.37	0.36	0.01	235
1 01	3 18	33	0.01	0.00	0.01	0	0.00	0.00	153	0.44	0.43	0.01	277
1 01	3 24	34	0.01	0.00	0.01	0	0.00	0.00	154	0.59	0.58	0.01	344
1 01	3 30	35	0.01	0.00	0.01	0	0.00	0.00	155	1.33	1.32	0.01	566
1 01	3 36	36	0.01	0.00	0.01	0	0.00	0.00	156	2.36	2.35	0.01	1061
1 01	3 42	37	0.01	0.00	0.01	0	0.00	0.00	157	0.74	0.73	0.01	1156
1 01	3 48	38	0.01	0.00	0.01	0	0.00	0.00	158	0.67	0.59	0.01	769
1 01	3 54	39	0.01	0.00	0.01	0	0.00	0.00	159	0.37	0.36	0.01	535
1 01	4 00	40	0.01	0.00	0.01	0	0.00	0.00	160	0.30	0.29	0.01	345
1 01	4 06	41	0.01	0.00	0.01	0	0.00	0.00	161	0.27	0.26	0.01	273
1 01	4 12	42	0.01	0.00	0.01	0	0.00	0.00	162	0.27	0.26	0.01	230
1 01	4 18	43	0.01	0.00	0.01	0	0.00	0.00	163	0.27	0.26	0.01	213
1 01	4 24	44	0.01	0.00	0.01	0	0.00	0.00	164	0.27	0.26	0.01	206
1 01	4 30	45	0.01	0.00	0.01	0	0.00	0.00	165	0.27	0.26	0.01	204
1 01	4 36	46	0.01	0.00	0.01	0	0.00	0.00	166	0.27	0.26	0.01	203
1 01	4 42	47	0.01	0.00	0.01	0	0.00	0.00	167	0.27	0.26	0.01	203
1 01	4 48	48	0.01	0.00	0.01	0	0.00	0.00	168	0.27	0.26	0.01	203
1 01	4 54	49	0.01	0.00	0.01	0	0.00	0.00	169	0.27	0.26	0.01	203
1 01	5 00	50	0.01	0.00	0.01	0	0.00	0.00	170	0.27	0.26	0.01	[illegible]
1 01	5 06	51	0.01	0.00	0.01	0	0.00	0.00	171	0.21	0.20	0.01	179
1 01	5 12	52	0.01	0.00	0.01	0	0.00	0.00	172	0.21	0.20	0.01	171
1 01	5 18	53	0.01	0.00	0.01	0	0.00	0.00	173	0.21	0.20	0.01	16[illegible]
1 01	5 24	54	0.01	0.00	0.01	0	0.00	0.00	174	0.21	0.20	0.01	16[illegible]
1 01	5 30	55	0.01	0.00	0.01	0	0.00	0.00	175	0.21	0.20	0.01	15[illegible]
1 01	5 36	56	0.01	0.00	0.01	0	0.00	0.00	176	0.21	0.20	0.01	15[illegible]
1 01	5 42	57	0.01	0.00	0.01	0	0.00	0.00	177	0.21	0.20	0.01	156
1 01	5 48	58	0.01	0.00	0.01	0	0.00	0.00	178	0.21	0.20	0.01	15[illegible]
1 01	5 54	59	0.01	0.00	0.01	0	0.00	0.00	179	0.21	0.20	0.01	15[illegible]
1 01	6 00	60	0.01	0.00	0.01	0	0.00	0.00	180	0.21	0.20	0.01	1[illegible]

LOUIS BERGER & ASSOCIATES INC.

BY ______ DATE ______ SHEET NO. ____ OF ____

CHKD. BY ______ DATE ______ PROJECT ______

SUBJECT ______

1.01	6.06	61	0.04	0.03	0.01	7	0.00	0.00	181	0.01	0.00	0.01	114
1.01	6.12	62	0.04	0.03	0.01	18	0.00	0.00	182	0.01	0.00	0.01	46
1.01	6.18	63	0.04	0.03	0.01	23	0.00	0.00	183	0.01	0.00	0.01	21
1.01	6.24	64	0.04	0.03	0.01	25	0.00	0.00	184	0.01	0.00	0.01	10
1.01	6.30	65	0.04	0.03	0.01	26	0.00	0.00	185	0.01	0.00	0.01	6
1.01	6.36	66	0.04	0.03	0.01	26	0.00	0.00	186	0.01	0.00	0.01	4
1.01	6.42	67	0.04	0.03	0.01	26	0.00	0.00	187	0.01	0.00	0.01	3
1.01	6.48	68	0.04	0.03	0.01	26	0.00	0.00	188	0.01	0.00	0.01	3
1.01	6.54	69	0.04	0.03	0.01	26	0.00	0.00	189	0.01	0.00	0.01	3
1.01	7.00	70	0.04	0.03	0.01	26	0.00	0.00	190	0.01	0.00	0.01	3
1.01	7.06	71	0.04	0.03	0.01	26	0.00	0.00	191	0.01	0.00	0.01	3
1.01	7.12	72	0.04	0.03	0.01	26	0.00	0.00	192	0.01	0.00	0.01	3
1.01	7.18	73	0.04	0.03	0.01	26	0.00	0.00	193	0.01	0.00	0.01	3
1.01	7.24	74	0.04	0.03	0.01	26	0.00	0.00	194	0.01	0.00	0.01	3
1.01	7.30	75	0.04	0.03	0.01	26	0.00	0.00	195	0.01	0.00	0.01	3
1.01	7.36	76	0.04	0.03	0.01	26	0.00	0.00	196	0.01	0.00	0.01	3
1.01	7.42	77	0.04	0.03	0.01	26	0.00	0.00	197	0.01	0.00	0.01	3
1.01	7.48	78	0.04	0.03	0.01	26	0.00	0.00	198	0.01	0.00	0.01	3
1.01	7.54	79	0.04	0.03	0.01	26	0.00	0.00	199	0.01	0.00	0.01	3
1.01	8.00	80	0.04	0.03	0.01	26	0.00	0.00	200	0.01	0.00	0.01	3
1.01	8.06	81	0.04	0.03	0.01	26	0.00	0.00	201	0.01	0.00	0.01	3
1.01	8.12	82	0.04	0.03	0.01	26	0.00	0.00	202	0.01	0.00	0.01	3
1.01	8.18	83	0.04	0.03	0.01	26	0.00	0.00	203	0.01	0.00	0.01	3
1.01	8.24	84	0.04	0.03	0.01	26	0.00	0.00	204	0.01	0.00	0.01	3
1.01	8.30	85	0.04	0.03	0.01	26	0.00	0.00	205	0.01	0.00	0.01	3
1.01	8.36	86	0.04	0.03	0.01	26	0.00	0.00	206	0.01	0.00	0.01	3
1.01	8.42	87	0.04	0.03	0.01	26	0.00	0.00	207	0.01	0.00	0.01	3
1.01	8.48	88	0.04	0.03	0.01	26	0.00	0.00	208	0.01	0.00	0.01	3
1.01	8.54	89	0.04	0.03	0.01	26	0.00	0.00	209	0.01	0.00	0.01	3
1.01	9.00	90	0.04	0.03	0.01	26	0.00	0.00	210	0.01	0.00	0.01	3
1.01	9.06	91	0.04	0.03	0.01	26	0.00	0.00	211	0.01	0.00	0.01	3
1.01	9.12	92	0.04	0.03	0.01	26	0.00	0.00	212	0.01	0.00	0.01	3
1.01	9.18	93	0.04	0.03	0.01	26	0.00	0.00	213	0.01	0.00	0.01	3
1.01	9.24	94	0.04	0.03	0.01	26	0.00	0.00	214	0.01	0.00	0.01	3
1.01	9.30	95	0.04	0.03	0.01	26	0.00	0.00	215	0.01	0.00	0.01	3
1.01	9.36	96	0.04	0.03	0.01	26	0.00	0.00	216	0.01	0.00	0.01	3
1.01	9.42	97	0.04	0.03	0.01	26	0.00	0.00	217	0.01	0.00	0.01	3
1.01	9.48	98	0.04	0.03	0.01	26	0.00	0.00	218	0.01	0.00	0.01	3
1.01	9.54	99	0.04	0.03	0.01	26	0.00	0.00	219	0.01	0.00	0.01	3
1.01	10.00	100	0.04	0.03	0.01	26	0.00	0.00	220	0.01	0.00	0.01	3
0.00	0.00	101	0.04	0.03	0.01	26	0.00	0.00	221	0.01	0.00	0.01	3
0.00	0.00	102	0.04	0.03	0.01	26	0.00	0.00	222	0.01	0.00	0.01	3
0.00	0.00	103	0.04	0.03	0.01	26	0.00	0.00	223	0.01	0.00	0.01	3
0.00	0.00	104	0.04	0.03	0.01	26	0.00	0.00	224	0.01	0.00	0.01	3
0.00	0.00	105	0.04	0.03	0.01	26	0.00	0.00	225	0.01	0.00	0.01	3
0.00	0.00	106	0.04	0.03	0.01	26	0.00	0.00	226	0.01	0.00	0.01	3
0.00	0.00	107	0.04	0.03	0.01	26	0.00	0.00	227	0.01	0.00	0.01	3
0.00	0.00	108	0.04	0.03	0.01	26	0.00	0.00	228	0.01	0.00	0.01	3
0.00	0.00	109	0.04	0.03	0.01	26	0.00	0.00	229	0.01	0.00	0.01	[illegible]
0.00	0.00	110	0.04	0.03	0.01	26	0.00	0.00	230	0.01	0.00	0.01	3
0.00	0.00	111	0.04	0.03	0.01	26	0.00	0.00	231	0.01	0.00	0.01	3
0.00	0.00	112	0.04	0.03	0.01	26	0.00	0.00	232	0.01	0.00	0.01	3
0.00	0.00	113	0.04	0.03	0.01	26	0.00	0.00	233	0.01	0.00	0.01	3
0.00	0.00	114	0.04	0.03	0.01	26	0.00	0.00	234	0.01	0.00	0.01	3
0.00	0.00	115	0.04	0.03	0.01	26	0.00	0.00	235	0.01	0.00	0.01	3
0.00	0.00	116	0.04	0.03	0.01	26	0.00	0.00	236	0.01	0.00	0.01	3
0.00	0.00	117	0.04	0.03	0.01	26	0.00	0.00	237	0.01	0.00	0.01	3
0.00	0.00	118	0.04	0.03	0.01	26	0.00	0.00	238	0.01	0.00	0.01	3
0.00	0.00	119	0.04	0.03	0.01	26	0.00	0.00	239	0.01	0.00	0.01	3
0.00	0.00	120	0.04	0.03	0.01	26	0.00	0.00	240	0.01	0.00	0.01	3

LOUIS BERGER & ASSOCIATES INC.

BY ______ DATE ______ SHEET NO ______ OF ______
CHKD. BY ______ DATE ______ PROJECT ______
SUBJECT ______

					500 23.48 21.12 [illegible]	16326
					(596)(536)([illegible])(	462 35)
CFS	1156	291	[illegible]	48	16 [illegible]	
CMS	33	2	[illegible]	2	4[illegible]	
INCHES		18.78	21.11	21.11	21.11	
MM		474.44	536.17	536.17	536.17	
AC-FT		115	135	135	135	
THOUS CU M		142	16[illegible]	167	167	

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 1

CFS	[illegible]	120	[illegible]	24	8165
CMS	16	3	1	1	2[illegible]
INCHES		9.34	10.55	10.55	10.55
MM		237.22	268.07	268.09	268.09
AC-FT		59	68	68	68
THOUS CU M		74	83	83	83

ROUTED FLOW THROUGH RESERVOIR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP		LSTR
0.0	0.000	0.00	1	0	0	0		0

STAGE	1269.80	1270.00	1271.00	1271.40	1271.90	1272.00	1272.50	1273.00	1274.00
FLOW	0.00	5.00	70.00	108.00	154.00	1[illegible].00	496.00	1076.00	2690.00
CAPACITY=	0	84	86	96	10[illegible]	10[illegible]	106	117	128
ELEVATION=	1256	1270	1270	1271	1271	1272	1272	1273	1274

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
1269.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
[illegible]	[illegible]	[illegible]	[illegible]

STATION 2, PLAN 1, RATIO 1

END-OF-PERIOD HYDROGRAPH ORDINATES

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	OUTFLOW	STORAGE	STAGE
1.01	0.06	1	0.10	0		0	84	1269.8
1.01	0.12	2	[illegible]	0		[illegible]	84	1269.8
1.01	0.18	3	[illegible]	0		[illegible]	[illegible]	1269.8
1.01	0.24	4	0.[illegible]4	0		[illegible]	84	1269.8
1.01	0.30	5	[illegible]	0		[illegible]	84	1269.8
1.01	0.36	6	[illegible]	0		[illegible]	84	1269.8
1.01	0.42	7	0.70	0		0	84	1269.8
1.01	0.48	8	0.80	0		[illegible]	84	1269.8
1.01	0.54	9	0.90	0		0	84	1269.8
1.01	1.00	10	1.00	0		[illegible]	84	1269.8
1.01	1.06	11	1.10	0		0	84	1269.8
1.01	1.12	12	1.20	0		0	84	1269.8
1.01	1.18	13	1.30	0		0	84	1269.8
1.01	1.24	14	1.40	0		0	84	1269.8
1.01	1.30	15	1.50	0		0	84	1269.8
1.01	1.36	16	1.60	0		0	84	1269.8
1.01	1.42	17	1.70	0		0	84	1269.8
1.01	1.48	18	1.80	0		0	84	1269.8

BY [illegible] DATE [illegible] **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. [illegible] OF [illegible]

CHKD. BY ______ DATE ________ [illegible] PROJECT [illegible]

SUBJECT ________________ [illegible]

1.01	1.54	19	1.90	0	0	64	1269.8
1.01	2.00	20	2.00	0	0	64	1269.8
1.01	2.06	21	2.10	0	0	64	1269.8
1.01	2.12	22	2.20	0	0	64	1269.8
1.01	2.18	23	2.30	0	0	64	1269.8
1.01	2.24	24	2.40	0	0	64	1269.8
1.01	2.30	25	2.50	0	0	64	1269.8
1.01	2.36	26	2.60	0	0	64	1269.8
1.01	2.42	27	2.70	0	0	64	1269.8
1.01	2.48	28	2.80	0	0	64	1269.8
1.01	2.54	29	2.90	0	0	64	1269.8
1.01	3.00	30	3.00	0	0	64	1269.8
1.01	3.06	31	3.10	0	0	64	1269.8
1.01	3.12	32	3.20	0	0	64	1269.8
1.01	3.18	33	3.30	0	0	64	1269.8
1.01	3.24	34	3.40	0	0	64	1269.8
1.01	3.30	35	3.50	0	0	64	1269.8
1.01	3.36	36	3.60	0	0	64	1269.8
1.01	3.42	37	3.70	0	0	64	1269.8
1.01	3.48	38	3.80	0	0	64	1269.8
1.01	3.54	39	3.90	0	0	64	1269.8
1.01	4.00	40	4.00	0	0	64	1269.8
1.01	4.06	41	4.10	0	0	64	1269.8
1.01	4.12	42	4.20	0	0	64	1269.8
1.01	4.18	43	4.30	0	0	64	1269.8
1.01	4.24	44	4.40	0	0	64	1269.8
1.01	4.30	45	4.50	0	0	64	1269.8
1.01	4.36	46	4.60	0	0	64	1269.8
1.01	4.42	47	4.70	0	0	64	1269.8
1.01	4.48	48	4.80	0	0	64	1269.8
1.01	4.54	49	4.90	0	0	64	1269.8
1.01	5.00	50	5.00	0	0	64	1269.8
1.01	5.06	51	5.10	0	0	64	1269.8
1.01	5.12	52	5.20	0	0	64	1269.8
1.01	5.18	53	5.30	0	0	64	1269.8
1.01	5.24	54	5.40	0	0	64	1269.8
1.01	5.30	55	5.50	0	0	64	1269.8
1.01	5.36	56	5.60	0	0	64	1269.8
1.01	5.42	57	5.70	0	0	64	1269.8
1.01	5.48	58	5.80	0	0	64	1269.8
1.01	5.54	59	5.90	0	0	64	1269.8
1.01	6.00	60	6.00	0	0	64	1269.8
1.01	6.06	61	6.10	4	0	64	1269.8
1.01	6.12	62	6.20	9	0	64	1269.8
1.01	6.18	63	6.30	12	0	64	1269.8
1.01	6.24	64	6.40	13	1	64	1269.8
1.01	6.30	65	6.50	13	1	65	1269.8
1.01	6.36	66	6.60	13	1	65	1269.8
1.01	6.42	67	6.70	13	1	65	1269.9
1.01	6.48	68	6.80	13	2	65	1269.9
1.01	6.54	69	6.90	13	2	65	1269.9
1.01	7.00	70	7.00	13	2	65	1269.9
1.01	7.06	71	7.10	13	2	65	1269.9
1.01	7.12	72	7.20	13	3	65	1269.9
1.01	7.18	73	7.30	13	3	65	1269.9
1.01	7.24	74	7.40	13	3	65	1269.9
1.01	7.30	75	7.50	13	3	65	1269.9
1.01	7.36	76	7.60	13	3	66	1269.9
1.01	7.42	77	7.70	13	4	66	1269.9
1.01	7.48	78	7.80	13	4	66	1270.0
1.01	7.54	79	7.90	13	4	66	1270.0
1.01	8.00	80	8.00	13	4	66	1270.0
1.01	8.06	81	8.10	13	4	66	1270.0
1.01	8.12	82	8.20	13	5	66	1270.0
1.01	8.18	83	8.30	13	5	66	1270.0
1.01	8.24	84	8.40	13	5	66	1270.0
1.01	8.30	85	8.50	13	5	66	1270.0
1.01	8.36	86	8.60	13	6	66	1270.0
1.01	8.42	87	8.70	13	6	66	1270.0
1.01	8.48	88	8.80	13	7	66	1270.0
1.01	8.54	89	8.90	13	7	66	1270.0
1.01	9.00	90	9.00	13	7	66	1270.0
1.01	9.06	91	9.10	13	8	66	1270.0
1.01	9.12	92	9.20	13	[illegible]	67	1270.0
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	67	1270.0
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	67	1270.1
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1270.1
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1270.1
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]						[illegible]

BY ________ DATE ________   **LOUIS BERGER & ASSOCIATES INC.**   SHEET NO. ____ OF ____

CHKD. BY ________ DATE ________   PROJECT ________

SUBJECT ________

1.01	0.54	[illegible]	9.90	13	[illegible]	87	1270.1
1.01	1.00	100	10.00	13	10	87	1270.1
0.00	0.00	101	10.10	13	10	87	1270.1
0.00	0.00	102	10.20	13	10	87	1270.1
0.00	0.00	103	10.30	13	10	87	1270.1
0.00	0.00	104	10.40	13	10	87	1270.1
0.00	0.00	105	10.50	13	10	87	1270.1
0.00	0.00	106	10.60	13	11	87	1270.1
0.00	0.00	107	10.70	13	11	87	1270.1
0.00	0.00	108	10.80	13	11	87	1270.1
0.00	0.00	109	10.90	13	11	87	1270.1
0.00	0.00	110	11.00	13	11	87	1270.1
0.00	0.00	111	11.10	13	11	87	1270.1
0.00	0.00	112	11.20	13	11	87	1270.1
0.00	0.00	113	11.30	13	11	87	1270.1
0.00	0.00	114	11.40	13	11	87	1270.1
0.00	0.00	115	11.50	13	12	87	1270.1
0.00	0.00	116	11.60	13	12	87	1270.1
0.00	0.00	117	11.70	13	12	87	1270.1
0.00	0.00	118	11.80	13	12	87.	1270.1
0.00	0.00	119	11.90	13	12	87	1270.1
0.00	0.00	120	12.00	13	12.	87	1270.1
0.00	0.00	121	12.10	30.	12	87	1270.1
0.00	0.00	122	12.20	54.	14	87	1270.1
0.00	0.00	123	12.30	65	16	88	1270.2
0.00	0.00	124	12.40	69	19	88	1270.2
0.00	0.00	125	12.50	70.	22	89	1270.3
0.00	0.00	126	12.60	71	25	89	1270.3
0.00	0.00	127	12.70	71	27	89.	1270.3
0.00	0.00	128	12.80	71	29.	90	1270.4
0.00	0.00	129	12.90	71	32	90.	1270.4
0.00	0.00	130	13.00	71	34.	90	1270.4
0.00	0.00	131	13.10	74	35.	91	1270.5
0.00	0.00	132	13.20	82	38	91	1270.5
0.00	0.00	133	13.30	85	41	91	1270.6
0.00	0.00	134	13.40	86	43	92	1270.6
0.00	0.00	135	13.50	85	46	92	1270.6
0.00	0.00	136	13.60	85	48	92	1270.7
0.00	0.00	137	13.70	82.	50	93.	1270.7
0.00	0.00	138	13.80	88.	52	93	1270.7
0.00	0.00	139	13.90	85	54	93	1270.7
0.00	0.00	140	14.00	85	55	94	1270.8
0.00	0.00	141	14.10	93	57	94	1270.8
0.00	0.00	142	14.20	102	59	94	1270.8
0.00	0.00	143	14.30	106	62	95	1270.9
0.00	0.00	144	14.40	108.	64	95	1270.9
0.00	0.00	145	14.50	109	67	95	1270.9
0.00	0.00	146	14.60	109	69	96	1271.0
0.00	0.00	147	14.70	109	72	96	1271.0
0.00	0.00	148	14.80	109	74	96	1271.0
0.00	0.00	149	14.90	109.	77	96	1271.1
0.00	0.00	150	15.00	109	79	97	1271.1
0.00	0.00	151	15.10	109	82	97	1271.1
0.00	0.00	152	15.20	115	84	97	1271.1
0.00	0.00	153	15.30	130	87.	98	1271.2
0.00	0.00	154	15.40	172	92	98	1271.2
0.00	0.00	155	15.50	234	105	99	1271.3
0.00	0.00	156	15.60	550	125	102	1271.6
0.00	0.00	157	15.70	576	155	105	1271.9
0.00	0.00	158	15.80	394	240	107	1272.1
0.00	0.00	159	15.90	288.	~~[illegible]~~ 279	108	1272.2
0.00	0.00	160	16.00	182	286.	108	1272.1
0.00	0.00	161	16.10	136.	218	107	1272.1
0.00	0.00	162	16.20	115	180	106	1272.0
0.00	0.00	163	16.30	106	161	106	1272.0
0.00	0.00	164	16.40	103	157	105	1271.9
0.00	0.00	165	16.50	102	154	105	1271.9
0.00	0.00	166	16.60	102	150	105	1271.9
0.00	0.00	167	16.70	102	147	104	1271.8
0.00	0.00	168	16.80	101	144	104	1271.8
0.00	0.00	169	16.90	101	141	103	1271.8
0.00	0.00	170	17.00	101	139	103	1271.7
[illegible]	[illegible]	[illegible]	17.10	[illegible]	[illegible]	102	1271.7
[illegible]	0.00	172	17.20	[illegible]	[illegible]	102	1271.7
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	102	1271.6
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	102	1271.6
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1271.6
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1271.[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

BY ____ DATE ____ **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. ____ OF ____

CHKD. BY ______ DATE ______ PROJECT ______

SUBJECT ______

0.00	0.00	179	17.90	79	111	100	1271.4
0.00	0.00	180	18.00	79	109	100	1271.4
0.00	0.00	181	18.10	57	106	99	1271.4
0.00	0.00	182	18.20	20	101	97	1271.3
0.00	0.00	183	18.30	10	95	96	1271.3
0.00	0.00	184	18.40	5	88	96	1271.2
0.00	0.00	185	18.50	3	82	97	1271.1
0.00	0.00	186	18.60	2	76	96	1271.1
0.00	0.00	187	18.70	2	70	96	1271.0
0.00	0.00	188	18.80	2	66	95	1270.9
0.00	0.00	189	18.90	2	63	95	1270.9
0.00	0.00	190	19.00	2	60	94	1270.8
0.00	0.00	191	19.10	2	56	94	1270.8
0.00	0.00	192	19.20	2	53	93	1270.7
0.00	0.00	193	19.30	2	51	93	1270.7
0.00	0.00	194	19.40	2	48	92	1270.7
0.00	0.00	195	19.50	2	45	92	1270.6
0.00	0.00	196	19.60	2	43	92	1270.6
0.00	0.00	197	19.70	2	41	91	1270.6
0.00	0.00	198	19.80	2	39	91	1270.5
0.00	0.00	199	19.90	2	37	91	1270.5
0.00	0.00	200	20.00	2	35	90	1270.5
0.00	0.00	201	20.10	2	33	90	1270.4
0.00	0.00	202	20.20	2	31	90	1270.4
0.00	0.00	203	20.30	2	30	90	1270.4
0.00	0.00	204	20.40	2	28	89	1270.4
0.00	0.00	205	20.50	2	27	89	1270.3
0.00	0.00	206	20.60	2	25	89	1270.3
0.00	0.00	207	20.70	2	24	89	1270.3
0.00	0.00	208	20.80	2	23	89	1270.3
0.00	0.00	209	20.90	2	22	89	1270.3
0.00	0.00	210	21.00	2	20	88	1270.2
0.00	0.00	211	21.10	2	19	88	1270.2
0.00	0.00	212	21.20	2	18	88	1270.2
0.00	0.00	213	21.30	2	17	88	1270.2
0.00	0.00	214	21.40	2	17	88	1270.2
0.00	0.00	215	21.50	2	16	88	1270.2
0.00	0.00	216	21.60	2	15	88	1270.2
0.00	0.00	217	21.70	2	14	87	1270.1
0.00	0.00	218	21.80	2	14	87	1270.1

PEAK OUTFLOW IS 279 ~~280~~ AT TIME 19.90 HOURS

CFS	280	105	33	33	7923
CMS	8	3	1	1	224
INCHES		8.16	10.24	10.24	10.24
MM		207.29	260.01	260.01	260.01
AC-FT		52	65	65	65
THOUS CU M		64	81	81	81

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

RATIOS APPLIED TO FLOWS

OPERATION	STATION	AREA	PLAN	RATIO 1 0.50
HYDROGRAPH AT	1	0.12 (0.31)	1	578 (16.[illegible])
ROUTED TO	2	0.12 (0.31)	1	280 (7.93)

SUMMARY OF DAM SAFETY ANALYSIS

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1269.80	1269.80	1272.00
STORAGE	54	54	106
OUTFLOW	0	0	162

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
0.50	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	19.90	0.00

BY [illegible] DATE [illegible]

CHKD. BY ______ DATE ______

SUBJECT [illegible] DAM BREA[illegible] [illegible]

LOUIS BERGER & ASSOCIATES INC.

SHEET NO. [illegible] OF [illegible]

PROJECT [illegible]

```
A1   [illegible]
A2   [illegible]
A3   APRIL [illegible]
B    1[illegible]      [illegible]     [illegible]       0       0       0      [illegible]     0     [illegible]     0
B1   [illegible]
        1        1        1
J1   [illegible]
K       1                                                    1
K1   INFLOW HYDROGRAPH TO RESERVOIR
M       1        [illegible]       12              12
P       0       2[illegible]       [illegible]       [illegible]        108
T                                                            5       1
W2               12
X       [illegible]        [illegible]       1
K       1        [illegible]                                          1
K1   ROUTED FLOW THROUGH RESERVOIR
Y                                   1
Y1      1                                                  84 2      -1
Y4 1269 5     [illegible]     [illegible]    1271 [illegible]  1[illegible]1 [illegible]    [illegible]  [illegible]    1273      [illegible]
Y5      [illegible]        5       70      108     1[illegible]4     162    [illegible]     1076     [illegible]
$S      0     84 2     [illegible] 1     [illegible] 7     [illegible]    104.9   10[illegible] [illegible]   116 8    12[illegible]
$E   12[illegible]  1269.8    1270    1271   1271 4  1271 9    12[illegible]     1273     1274
$$1269 [illegible]
$D  1272
$B      [illegible]        1     1264       1   126[illegible] 8    1272
K       1        [illegible]                                          1
K1   CHANNEL ROUTE  REACH 2-3
Y                                   1
Y1      1
Y6     [illegible]       04      [illegible]  1256 2     1265     350     001
Y7      0     1265      10     1260       43    1259     105   1256.2      245  1256 2
Y7    2[illegible]     12[illegible]     [illegible]     1260      263    1265
K       1        4                                           1
K1   CHANNEL ROUTE  REACH 3-4
Y                                   1
Y1      1
Y6     [illegible]       04      [illegible]     1205     1215     [illegible]     [illegible]
Y7      [illegible]     1215      22     1212       44    1208      50     1205       60     1205
Y7     6[illegible]     1208      88     1212      110    1215
K      99
```

SUMMARY OF DAM SAFETY ANALYSIS

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	126[illegible] 80	1269 80	1272 00
STORAGE	84	84	10[illegible]
OUTFLOW	0	0	162

RATIO OF PMF	MAXIMUM RESERVOIR W.S. ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
[illegible] 50	12[illegible]	[illegible]	10[illegible]	15[illegible]	0 00	16 00	0 00

PLAN 1 STATION 3 (350 DOWNSTREAM TENNIS COURTS)

RATIO	MAXIMUM FLOW, CFS	MAXIMUM STAGE, FT	TIME HOURS
[illegible] 50	15[illegible]	125[illegible] 2	16. 10

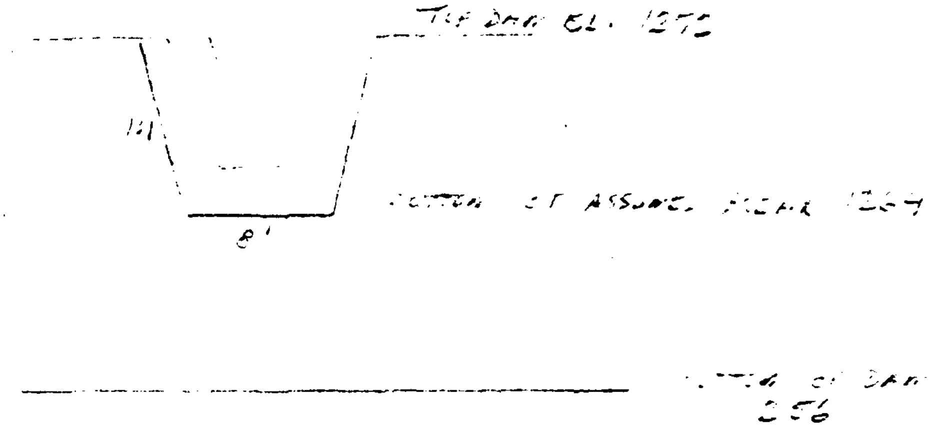
ELEV. OF TENNIS CTS. 1256.2

PLAN 1 STATION 4 (650' DOWNSTREAM)

RATIO	MAXIMUM FLOW, CFS	MAXIMUM STAGE, FT	TIME HOURS
[illegible] 50	15[illegible]	120[illegible]	16 10

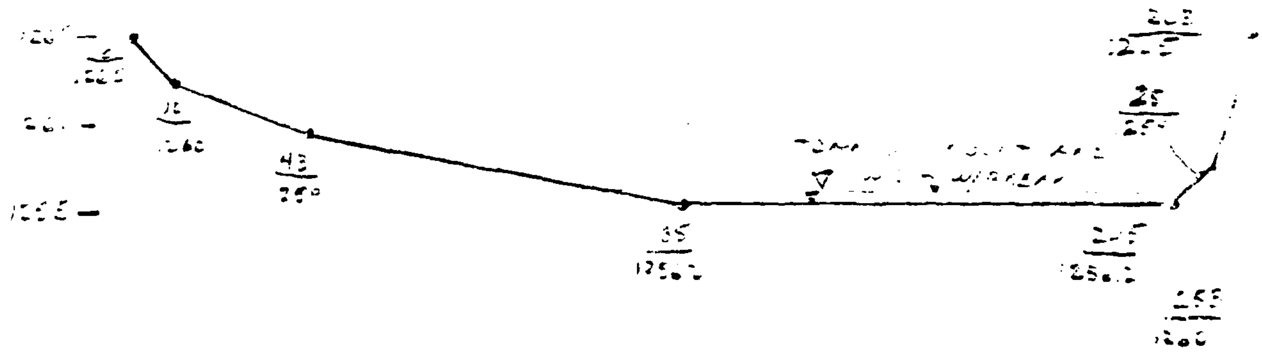
ELEVATION OF STREAM 1205.0

DAM BREAK DATA

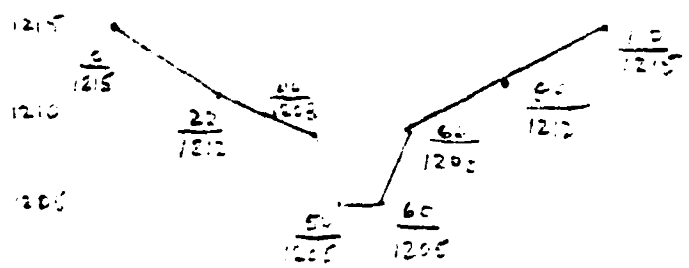


2. DOWNSTREAM CROSS-SECTIONS

REACH 3-3 — 350' DOWNSTREAM INCLUDE TENNIS COURT



REACH 3-4 - 650' DOWNSTREAM



ILME